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AUTHOR Dumont, Richard G.; Troelstrup, Richard L.
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ABSTRACT

Use of the American College Testing (ACT) Program assessment battery for the measurement of student growth at a regional state university is described. A stratified random sample of 112 seniors at Tennessee Technological University was given the residual form of the ACT Assessment battery for comparison with their pre-college ACT test performance. Comparison is also made with a previous study that examined educational growth after two years of college. Other quantitative predictors of educational growth were examined that might reflect the quality of educational exposure. Number of courses in a subject, number of quarter hours in a subject, and number of quality points in a subject were found to be poorer predictors than grade point average. It is suggested that while the ACT entrance exam appeared to be a useful measure of educational growth, there were some problems in terms of ceiling effects with the ACT standard scores. (Author/SW)

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MEASURES AND PREDICTORS OF EDUCATIONAL GROWTH WITH FOUR YEARS OF COLLEGE*

by

Richard G. Dumont, Ph.D.
Professor of Sociology and Chairman,
Department of Sociology and Philosophy
Tennessee Technological University
P.O. Box 5052
Cookeville, Tennessee 38501
Tel. (615) 528-3437

and

Richard L. Troelstrup, Ph.D.
Associate Professor of Psychology
Department of Educational Psychology
Tennessee Technological University
P.O. Box 5031
Cookeville, Tennessee 38501
Tel. (616) 528-4175

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Mary Corcoran
University of Minnesota
(Editor, AIR Forum Publications)

MEASURES AND PREDICTORS OF EDUCATIONAL GROWTH WITH FOUR YEARS OF COLLEGE

(Abstract)

A stratified random sample of 112 seniors at Tennessee Technological University were given the residual form of the ACT assessment battery for comparison with their pre-college ACT test performance. A detailed comparison with a previous study (Lenning, Munday and Maxey, 1968), which examined educational growth after two years of college, forms the basis of the report. In addition other quantitative predictors of educational growth were examined that might reflect the quality of educational exposure. Number of courses in a subject, number of quarter hours in a subject, and number of quality points in a subject were poorer predictors than grade point average. While the ACT entrance exam appears to be a useful measure of educational growth, there are some problems in terms of ceiling effects with the ACT standard scores.

MEASURES AND PREDICTORS OF EDUCATIONAL GROWTH WITH FOUR YEARS OF COLLEGE

The concern with the assessment of the educational progress of students has received increasing emphasis in recent years. In large part this phenomenon is attributable to the growing demands for increasing the public accountability of higher education. In a recent and substantative review of the impact of higher education, the "Goals for Individual Students" appearing in Bowen's Investment in Learning are essentially general education goals. They include the major categories of "Cognitive Learning, Emotional and Moral Development, Practical Competence, Direct Satisfactions and Enjoyments from College Education and Avoidance of Negative Outcomes for individual students." Of these several categories there is little doubt that the cognitive area especially such subdomains as verbal and quantative skills, substantitive knowledge, and rationality are of special interest to legislative and executive officers as well as governing boards and coordinating agencies. The attention to cognitive learning is reflected also in concerted attempts to develop valid and reliable instruments for the objective assessment of general education cognitive outcomes. Two examples are the "COMP" or College Outcomes Measuring Project by American College Testing Program (ACT) and the Undergraduate Assessment Program Area Tests by the Educational Testing Service (ETS).

An important question which has yet to be answered satisfactorily concerns the potential utility of a college admissions test as a measure of cognitive learning. The advantage of being

able to employ such a test for the assessment of cognitive progress should be readily apparent. First, since most students at most institutions are required to submit admission test scores as a necessary component of the application process, the possibility exists for indicating cognitive change by using another form of the same test with the graduating student. Since historical data are generally available for several years, gain or growth scores can be assessed currently. Utilizing specially designed instruments would require current assessment of freshman and a wait of four years. The immediacy of accountability pressures of boards, legislatures and other funding bodies limit the use of new tests. A second advantage of admissions tests in the assessment of cognitive growth is their standardized nature. Such standardization allows for both intracurricular and inter-institutional comparisons. An institution can thus assess its progress over time as well as its beginning and end products with other comparable institutions. A third advantage of such exams is closely related to the second. Because of their widespread use for admission purposes, naturally they are well known by legislators and other interested officials. As such they have a potential for acceptibility through their established use. A fourth advantage of such tests is that their reliability and validity have been generally well documented. Despite recent questions concerning the "discriminating" aspects of such tests, few would dispute their general reliability and validity as predictors of academic success in contemporary higher education institutions in the United States.

Another important advantage of standardized tests, such as the ACT, have been cited in a 1968 study by Lenning, Munday and Maxey. In particular they argue that they may be advantageous as a measure of general education in that they appear to be optimally balanced in terms of the degree to which they are "curriculum oriented." In the words of the authors:

> Designed for college admissions, the ACT tests are generalized measures of educational development in the subject matter areas of English, mathematics, social studies, and natural sciences. As such the tests are more curriculum-oriented than scholastic aptitude tests that yield two highly generalized scores, one verbal and one mathematics, but less curriculum-oriented than some tests available at the secondary school level. This is necessary because a college admissions test cannot be so curriculum-oriented that it gives a systematic advantage to students using a specific textbook or who are in a particular curriculum.
>
> The more curriculum-oriented a test, the more the test would be expected to be sensitive to instruction and to specific student growth. Because the ACT tests are somewhat curriculum-oriented and are at least moderately correlated with academic success in college, we could logically try measuring change with such instruments. (p. 145)

The five major advantages of being able to employ an admissions test for the assessment of student growth are counter balanced by the generally recognized potential disadvantages involving the use of such tests. Lenning, Munday, and Maxey (1968) have clearly articulated these problems in their study. In addition to the ever-present problems of regression effect, ceiling effect, content effect, and reliability effect, they also discussed the following five problems involved in their own attempts to utilize the ACT assessment to measure "Student Educational Growth During the First Two Years of College:"

> In addition to problems in measuring change, there are certain other limitations to this study. First, we used gain on the respective subtests to study the effects of courses and majors, when it might have been better to construct variables of "potential" in the four academic areas of the tests, based on the optimal weighting of the tests used routinely for the institutional prediction of college grades. In other words, we used content rather than predictive validity in dealing with educational development in the four areas of the tests.
>
> Second, there was no control for maturational effects. ACT-tested students who did not go to college could be retested at the end of the same time interval and their changes compared with college students.
>
> Third, there was no control for student input on an institutional level. This was justified on the theory that institutional differences were not of interest in this study since we were focusing on the educational development of college students in general.
>
> Fourth, almost a year of high school experience occurred after the pretests. A study with the pretest given at the beginning of the college freshman year would avoid this problem.
>
> Fifth, the motivation to do well on the tests may have been considerably greater when the tests (pretest) were written for college admissions, than when the posttest occurred. Some students might even purposely do poorly on the retest in order to show their rebellion. (pp. 152-153)

The present inquiry describes the experiences utilizing the ACT assessment for the measurement of student growth at a regional state university. A brief description of the context for and process of data gathering is followed by a presentation and discussion of the findings and their implications.

DATA

Data for the present study derive from the THEC Performance Funding Project at Tennessee Tech University, a pilot project conducted during the academic years 1976-77 and 1977-78 (Dumont,

1977a; 1977b; 1978a; 1978b).[1] The university project was part of a larger state-wide effort sponsored by the Tennessee Higher Education Commission (THEC) and funded to a total amount in excess of one-half million dollars by grants from the Fund for the Improvement of Postsecondary Education (FIPSE), the W.K. Kellogg Foundation, the Ford Foundation, and an anonymous donor. The state-level project involved as active participants the state-wide coordinating agency (THEC), two governing boards, and eleven public, state-supported institutions, including community colleges, regional universities, a university health science center, and comprehensive, research-oriented, doctoral-granting universities.

Of the several Performance Funding Project activities, perhaps the most interesting and significant were the pilot projects conducted at the eleven selected institutions from throughout the state (Bogue and Troutt, 1977). The major objectives of each of the pilot projects were as follows:

First Year

1976-1977. The first year of these pilot projects is dedicated to the development and/or identification of instructional goals and associated performance indicators.

Second Year

1977-1978. The second year calls for the acquisition of data on these indicators and the development of ways in which performance might be incorporated into the funding project (THEC, 1976).

One of the "objective" or test performance indicators utilized in the project were gain scores on the ACT assessment. Specifically, on the morning of March 28, 1978, the residual form of the ACT was administered to a stratified random sample of 112 seniors. Stratification was based upon sex, college and grade point average. Students took all four subtests of the ACT assessment; English usage, mathematics usage, social studies reading and natural sciences reading (American College Testing Program, 1973). Pre-college subtest scores on the ACT assessment were also available for each member of the sample.

FINDINGS

Table 1 presents statistics summarizing the principal findings of the study. The format was selected deliberately to allow for direct comparison to the Lenning, Munday, and Maxey study "Student Educational Growth During the First Two Years of College (1968) pp 150-151). For the various subtests of the ACT assessment, as well as for the ACT Composite, pretest and postest means, standard deviations, correlations, average gains and t values are presented. Additionally, to facilitate comparisons, gain scores are presented in terms of standard deviation units (the ratio of Average Gains to Pretest standard deviation), a procedure whose advantages have been discussed recently by Bowen (1977 , pp 100-103).

Focusing first upon the results for the total sample, we find both substantial and statistically significant gains in all cognitive areas. The composite mean gain scores range from a high of 3.46 to a low of 2.74 for mathematics. Utilizing Bowen's suggested

Table 1: Descriptive Statistics Pertaining to Gain Scores on the ACT Assessment for 71 Male and 41 Female, Tennessee Tech University Seniors on March 28, 1978.

Test	Pretest		Postest			Average Gain		Ratio of Gain to Pretest S.D.
	Mean	S.D.	Mean	S.D.	r		t	
ACT English								
Total Sample	20.01	5.77	23.24	4.57	.81	3.23	10.06*	.56
Males	18.39	5.48	22.14	4.12	.80	3.75	9.62*	.68
Females	22.71	5.32	25.46	4.60	.80	2.75	5.54*	.52
ACT Math								
Total Sample	21.78	7.82	24.52	6.52	.88	2.74	7.80*	.35
Males	22.69	7.13	25.42	5.82	.86	2.73	6.28*	.38
Females	20.12	8.73	22.78	7.15	.90	2.66	4.35*	.30
ACT Social Studies								
Total Sample	21.63	6.54	25.09	5.72	.77	3.46	8.72*	.53
Males	21.37	6.69	24.86	5.76	.76	3.49	6.65*	.52
Females	22.07	6.31	25.68	5.08	.75	3.61	5.53*	.57
ACT Natural Sciences								
Total Sample	24.33	5.74	27.61	5.20	.73	3.28	8.51*	.57
Males	24.68	5.65	28.06	4.60	.76	3.38	7.76*	.60
Females	23.78	5.96	27.00	5.51	.72	3.22	4.78*	.54
ACT Composite								
Total Sample	22.05	5.41	25.26	4.48	.91	3.21	14.66*	.59
Males	21.90	5.22	25.22	4.14	.90	3.32	12.22*	.64
Females	22.29	5.78	25.39	4.89	.91	3.10	8.04*	.54

*probability less than .0001

and empirically based typology for the characterization of change (1977, p.103) we would describe the gains in English, Social Studies, Natural Sciences, and the Composite as reflecting a "moderate increase" while the gain in Mathematics is seen as a relatively

small increase. These findings tend to be consistent with the literature surveyed and summarized in Bowen (1977, pp 63-103). Our results may be summarized as follows:

1. Upon entering the University males show somewhat higher scores in mathematics and natural sciences, and somewhat lower scores in English and social sciences. The females tend to indicate just the opposite pattern of performance. These results appear consistent with those of Lenning, Munday, and Maxey (1968).

2. Relatively, the same differentials persist throughout the collegiate experience, a finding also apparent in the Lenning, Munday and Maxey data.

3. With the exception of social studies, males show greater average gains than females, although none of the sex differentials are statistically significant. The greater gains for males also occurred in the English, Mathematics and Composite of the Lenning, Munday, and Maxey study. Contrary to our findings, however, males also make greater gains in social studies, while in 3 out of 6 of the institutions in their sample females showed greater gain in natural sciences than males.

The data of Table 2 allow further comparisons of our data to those of the Lenning, Munday and Maxey study. The data reveal that for both males and females, Tennessee Tech University seniors show greater gains in English and Mathematics than the sophomores in the Lenning, Munday and Maxey study. The greater gain for Tennessee Tech University seniors is evident in the composite scores. Although the same pattern is to be observed in social sciences and natural sciences, in a few instances Lenning, Munday and Maxey sophomores show greater gains than Tennessee Tech University seniors. In the ratio of average gain to pretest standard deviation Tennessee Tech University seniors had higher ratios than the other sample, except for one school (E2) on the ACT social studies reading test. It is

Table 2: Comparison of Gains on the ACT Assessment of Tennessee Tech University Seniors with the Six Institutions Sampled in the Lenning, Munday, and Maxey Study (1968)

Institution and Years Attended	Males		Females	
	Average Gain	Ratio of Gain to Pretest S.D.	Average Gain	Ratio of Gain to Pretest S.D.
ACT English				
A1	1.53	.31	1.01	.19
A2	.83	.15	1.02	.20
B2	.92	.20	-.33	-.08
C2	.67	.17	.10	.03
D2	1.79	.36	-.29	-.08
E2	.38	.11	-.34	-.10
TTU3+	3.75	.68	2.75	.52
ACT Mathematics				
A1	1.04	.19	.92	.15
A2	1.00	.16	1.19	.22
B2	.42	.07	-.78	-.11
C2	.94	.18	.92	.18
D2	.71	.12	.42	.08
E2	1.35	.28	1.29	.27
TTU3+	2.73	.38	2.66	.30
ACT Social Stud.				
A1	2.67	.45	1.41	.22
A2	3.39	.57	2.28	.46
B2	1.43	.26	1.81	.33
C2	1.88	.39	1.39	.25
D2	1.82	.33	.38	.07
E2	4.03	.85	3.87	.91
TTU3+	3.49	.52	3.61	.57
ACT Natural Sci.				
A1	2.29	.40	1.24	.19
A2	3.89	.57	2.42	.43
B2	1.04	.20	1.19	.21
C2	1.60	.34	1.09	.23
D2	.50	.09	2.16	.47
E2	1.79	.39	2.16	.45
TTU3+	3.38	.60	3.22	.54
ACT Composite				
A1	1.84	.41	1.12	.21
A2	2.26	.44	1.67	.39
B2	.93	.21	.42	.09
C2	1.32	.36	.83	.21
D2	1.27	.29	.58	.15
E2	1.94	.59	1.80	.57
TTU3+	3.32	.64	3.10	.54

probably safe to say that in the case of many Tennessee Tech University seniors their formal exposure to English, mathematics, social studies, and natural sciences was completed by the end of the sophomore year.

In addition to differentiating educational growth by sex, Lenning, Munday, and Maxey also found inter-institutional variability. Intra-institutional variability for our data can be seen as inter-college differences in Table 3. Although substantial differences in average gain occurs among the colleges for all subtests, especially in social sciences and natural sciences, the extreme degree of intra-college variability results in correspondingly small and non significant F ratios, as the analysis of variance summary statistics reveal. In a closer examination of Table 3 it is interesting to note that the largest gains are found among student groups least likely to take courses in the area that would be most likely to promote gains. Ignoring the English subtest, where course requirements are reasonably uniform across colleges, Business Administration and Education majors probably the least likely to take mathematics courses, made the highest gains on that subtest. Similarly, Business Administration and Engineering majors made the highest gains in the social sciences subtest. The pattern continues, where Education, Agriculture and Home Economics, and Business Administration majors, being least likely to take courses in the natural sciences made higher gains on this subtest. While these differences are not significant they would support the rationale for a broad educational experience.

Table 3: Gain Scores on the ACT Assessment for 112 seniors, Subdivided by College of Student Major

ACT Assessment Subtest and College*	Gain Scores		Summary of ANOVA				
	Mean	S.D.	Source	df	SS	MS	F
ACT English							
Agricul and Home Econ.	3.00	2.04	Bet Grp	4	37.74	9.43	.48
Arts and Sciences	3.10	3.57	With Grp	107	1146.76	10.72	
Business Admin.	3.39	3.71	Total	111	1184.49		
Education	4.60	3.36					
Engineering	3.03	2.99					
ACT Mathematics							
Agricul and Home Econ	1.67	4.81	Bet Grp	4	15.58	3.90	.27
Arts and Sciences	2.71	3.39	With Grp	107	1539.69	14.39	
Business Admin.	3.00	3.46	Total	111	1555.28		
Education	2.90	4.67					
Engineering	2.81	3.28					
ACT Social Studies							
Agricul and Home Econ	4.25	3.55	Bet Grp	4	87.32	21.83	1.18
Arts and Sciences	2.65	4.44	With Grp	107	1982.54	18.53	
Business Admin.	4.67	5.16	Total	111	2069.86		
Education	2.50	4.06					
Engineering	4.16	4.03					
ACT Natural Science							
Agricul and Home Econ	3.67	4.62	Bet Grp	4	53.35	14.84	.98
Arts and Sciences	2.94	4.23	With Grp	107	1629.08	15.23	
Business Admin.	3.56	5.07	Total	111	1688.43		
Education	4.65	3.05					
Engineering	2.58	2.85					
ACT Composite							
Agricul and Home Econ	3.25	2.53	Bet Grp	4	11.47	2.87	.51
Arts and Sciences	2.90	2.18	With Grp	107	601.03	5.62	
Business Admin.	3.56	2.71	Total	111	612.49		
Education	3.75	2.38					
Engineering	3.06	2.28					

* Agriculture and Home Economics (N=12)
Arts and Sciences (N=31
Business Administration (N=18)
Education (N=20)
Engineering (N=31)

A major concern of the Lenning, Munday and Maxey study were the relationships between what may be called exposure to certain courses or topic areas and gain scores. Whether taking a course in a particular subject area or majoring in a subject area affected one's gain score in that area. In this regard they found that:

> "Students who take a college mathematics course show more gain in ACT mathematics scores. No such growth is detectable for students who take a social sciences course (p.149) .....The available data did not permit an adequate study of the effect of having a college English or science course." (p.152)

Further more they found that:

> "Generally a student's educational growth is unrelated to his major" (p.152)

The questions of the relationship of "exposure" to certain courses, topic areas, and majors are also of concern in the present study. The zero order correlations of Table 4 allow some insights into these relationships. Here, major is treated as a "dummy variable" (e.g. science and engineering majors are coded as 1 on Natural Sciences, while social sciences, business administration, humanities, and education majors etc. are coded as 0). Since detailed data on courses taken were available on all our students, it was possible to utilize more refined "course exposure" data for our study. Rather than simply indicate whether a student had a college course in the subject area (a dichotomous variable) as in the Lenning, Munday and Maxey (1968) study, our indicators are quantitative. For each subject they include "Number of Courses in Subject Matter Area," "Number of Quarter Hours in Subject Matter Area,""Number of Quality Points in Subject Matter Area," and "Quality Point Average in Subject Matter Area". In addition to the

Table 4: Selected Correlates of ACT Assessment Gain Scores for 112 Seniors at Tennessee Tech University

Correlate	ACT Assessment Gain Scored				
	English	Mathematics	Social Studies	Natural Sciences	Composite
ACT Pretest Score	-.61***	-.57***	-.55***	-.53***	-.60***
Major (Dummy Variable)	.05	.01	-.04	-.09	--
Number of Courses in Subject Matter	.03	-.03	-.10	.08	-.12
Number of Quarter Hours in Subject Matter Area	-.04	-.04	-.09	.08	-.16*
Number of Quality Point in Subject Matter Area	-.07	-.10	-.13	.01	-.21*
Quality Point Average in Subject Matter Area	-.22**	-.25**	-.15	-.08	-.16*

* p less than .05
** p less than .01
*** p less than .001

"exposure" variable which can be thought of as indicators of institutional effects, correlations of gain scores with corresponding pretest scores are also presented. The data reveal substantial and statistically significant negative correlations of gain scores with the corresponding pre-college ACT subtest scores. Of the several "exposure" variables, however, only Quality Point Average (Grade Point Average), and Subject Matter Area show significant correlations with any of the ACT Assessment subtests. Specifically, Quality Point Average in English and Mathematics are negatively

correlated with gains in ACT English and ACT Mathematics subtests.

How are we to interpret these findings? The strong negative correlations between pre-college ACT and gain scores mean that the less able students gain most on the ACT tests. There are two possible "extreme" interpretations for these relationships. On the one hand, assuming ideal validity and reliability, we might argue that in terms of the basic cognitive area assessed by the ACT, the collegiate experience contributes positively to the growth of all students, especially for those who are average or below average. On the other hand, we might attribute our findings to problematic validity and reliability of the test. For example, negative correlations could be primarily due to ceiling, content, and basement effects. Our data suggest that the anwser lies somewhere between these two extremes. A detailed examination of gain scores by pretest results shows some ceiling and basement effects, for example, but substantial gains do occur at all pretest levels! The fact that gains do occur over the three plus years of college and that these gains are greater than through the sophomore year suggest the validity of gain scores on the ACT admissions test for the assessment of general education. However, the lack of significant correlations with "exposure variables, e.g. the number of quarter hours earned, the number of courses taken, etc. raises questions about demonstrable institutional effects. Furthermore, a definitive answer is precluded by recognition of the fact that this study suffers from most of the same difficulties reported and discussed by Lenning, Munday and Maxey (1968).

To formally assess the question of basement and ceiling effects Table 5 presents a summary of analysis of variance with the 112 seniors stratified in apprroximate quartiles based on pretest scores.

Table 5: Summary of Analysis of Variance of Raw Gain Scores by Approximate Pretest ACT Quartile.

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Ratio	Prob.
Total	111	621.42	5.60		
Between Grps	3	206.94	68.98	18.01	.001
Within Grps	108	414.48	3.83		

Quartile	Range of ACT	Number	Mean Gain
1st	9-17	27	4.77
2nd	18-22	28	4.32
3rd	23-26	31	2.42
4th	27-33	26	1.38

It is clear that there appears to be substantial ceiling effects since it is difficult to assume that the more able student learns less than the less able student. One possible approach to lessen the ceiling effect of ACT standard scores is to transform standard scores to Z scores, thus gain could be in terms of Z units. This approach does tend to weight change from low ACT scores and from high scores. Table 6 presents an analysis on the same data in Table 5 but in terms of Z score gain. There is still significant differences indicating the presence of a ceiling affect though it is somewhat attenuated. It would appear that some better transformation is needed. Without a readily available transformation

Table 6: Summary of Analysis of Variance of Gain Scores Expressed in Z Values by Approximate Pretest ACT Quartile

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Ratio	Prob.
Total	111	23.30	.21		
Between Grps	3	2.84	.95	5.00	.005
Within Grps	108	20.46	.19		

Quartile	Range of ACT	Number	Mean Gain (Z's)
1st	9-17	27	.83
2nd	18-22	28	.79
3rd	23-26	31	.62
4th	27-33	26	.41

perhaps the best suggestion would be to stratify samples in terms of ability to lessen the ceiling effects.

REFERENCES

American College Testing Program. Assessing students on the way to college: Technical report for the ACT assessment program. Iowa City, Iowa: ACT, 1973.

Bogue, E. Grady and William E. Troutt. Allocation of state funds on a performance criterion, the Performance Funding Project: A status report. Nashville, Tennessee: Tennessee Higher Education Commission, 1977.

Bowen, Howard R.. Investment in learning. San Francisco: Jossey-Bass, 1977.

Dumont, Richard G.. Instructional goals survey: THEC Performance Funding Project. Cookeville, Tennessee: THEC Performance Funding Project, 1977a.

Dumont, Richard G.. End-of-year report for the THEC Performance Funding Project at Tennessee Technological University. Cookeville, Tennessee: THEC Performance Funding Project, 1977b.

Dumont, Richard G.. Final report for the THEC Performance Funding Project at Tennessee Technological University. Cookeville, Tennessee: THEC Performance Funding Project, 1978a.

Dumont, Richard G.. Report on a pilot project in performance funding. Houston, Texas: Paper presented at the Eighteenth Annual Forum of the Association for Institutional Research, May 21-25, 1978b.

Lenning, Oscar T., L. A. Munday, and E. J. Maxey. Student Educational Growth During the First Two Years of College. College and University. 1969, Winter, 145-153.